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Article

Post-Fordist Production and Urban Industrial Land Use Patterns

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Abstract
Economic restructuring of the 21st century is changing the production methods and location requirements of most industries. Mass production on the outskirts of cities, as was common in 20th century Fordism, is largely being replaced by an economic model characterised by a multitude of networked small and medium-sized production sites as well as logistics facilities. In this article, we want to examine if this also creates the opportunity to combine some of the smaller industrial areas with the city as a whole and to initiate a transformation of these areas in favour of redensification and mixed use. Examining the case of Kassel, Germany, we take a closer look at the transformation processes from Fordism to post-Fordism and the possibilities for a smarter land use. In this largely industrially shaped region, younger companies such as the solar panel producer SMA are using new approaches in terms of urban planning and land use by building their low emission-factories on greyfields in an urban environment rather than on suburban greenfields. In our article, we survey selected industrial areas in Kassel and discuss their recent change as part of a broader development from Fordism to post-Fordism. Firstly, the study contains a theoretical discussion of commercial and industrial land-use patterns in both socio-economic models. Subsequently, an on-site analysis is carried out to determine the extent to which both economic models have influenced the use and shape of industrial areas in Kassel. Based on this analysis, we finally show criteria for how urban planning can help to ensure that this change is combined with an improvement in the spatial and design quality of the industrial areas and is meaningfully integrated into the sustainable development of the city region.

Keywords
economic structural change; industrial area; knowledge economy; post-Fordism; productive city; urban manufacturing

Issue
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1. Introduction

One of the key elements of urban planning in the 20th century was the goal of separating residential areas and workplaces as much as possible in order to protect the population from emissions emanating from industry. However, with the change in industrial production methods that has been taking place for some years now, building structures, location preferences, and spatial demands on the surroundings of production and distribution sites are also changing. This process is closely linked to the change from Fordist to post-Fordist production. Instead of large vertically integrated factories, complex networks of diverse smaller production sites are now emerging. The more pronounced small-scale nature of these new factories, an increasing service orientation as well as knowledge-intensive and low-emission production processes make it possible to locate some of these industrial facilities not only outside the city, but also back in the city. This makes a functional, structural, and urban-spatial adaptation of industrial areas possible and can help to adapt the traditional structures to today’s demands for sustainability and urban development quality.

In this article, we want to trace this process by examining in detail the transformation of the commercial and industrial sector in the city of Kassel, Germany, and the changing spatial structures there. The focus is on the questions of how the post-Fordist restructuring is transforming the industrial areas in Kassel, whether this change leads to different spatial requirements, and to what extent this means that some new industrial sites can be built in existing urban small-scale industrial areas. To this end, we first present in the theoretical part what the core elements of the economic models of Fordism and post-Fordism are, what effects this has on the spatial structure of the economy, society and the city, and what adaptation needs of industrial areas result from this in functional and urban planning terms. Building on this, the empirical part examines these aspects in detail using the city of Kassel as a case study. To this end, an overview of the industrial area stock and the previous transformation processes in the production-dominated region of Kassel-Baunatal will be given. Then, the two industrial areas—Waldau and Bettenhausen—are analysed in more detail, especially with regard to urban structures and building adaptations. And finally, in the last section, implications for the further planning of industrial areas in the context of future transformation processes are derived from the theoretical opportunities for change and the findings from the case studies.

2. From Fordist to Post-Fordist Production

Fordism and post-Fordism are terms that each describe an economic form characterised by certain modes of production. These economic models have different effects on society, in the sense of its models of work, life, and consumption, as well as on space, in the sense of location decisions, flows of goods, and urban structures. In the next two sections we describe first the impact on society and then the impact on space.

2.1. Economic and Social Model

Fordism is named after car manufacturer Henry Ford, who further developed assembly line work by breaking down the work processes into the smallest units so that even unskilled workers could perform them. In combination with an extreme standardisation of products, this increased productivity and reduced manufacturing costs. As products became cheaper, it was also possible for workers to purchase goods of their own production. In addition, greater importance was attached to the negotiation of wages, so that domestic demand was high. Mass production thus made mass consumption possible, which ultimately led to general social prosperity. Starting in the USA, Fordism spread to Europe, where it had a far-reaching effect after the Second World War. Linked to this development was a tendency towards a standardised model of work and life. Employment relationships usually consisted of long-term contracts and comparatively high wages. One man's work was therefore sufficient to finance the cost of living. The small family, in which the husband was responsible for gainful employment and the wife for running the household and bringing up the children, therefore dominated as the ideal-typical image of the way of life. Fordism finally even made the suburban housing model possible for a broad middle class, which had previously been reserved for the upper classes (Häußermann, 2012).

In the 1970s, Fordism started to lose its significance as an economic and social model. Saturated markets, improved technologies in the area of telecommunications, deregulation of financial markets, and policies that facilitated international investment let to an increased outsourcing of standardised production to low-wage countries (see Figure 1). Closely related to this, the importance of internationally oriented companies and service industries, which finance and organise this global process of spatial distribution of economic activities and are mainly concentrated in the metropolises, increased (Taylor, 2000). Since the new jobs are mainly created either in the highly qualified business services sector or in the low-wage service sector, like cleaning, food preparation, or retail work, the number of jobs increases especially at the upper and lower end of the income scale. This social polarisation is particularly evident in the well-connected centres of the world economy known as global cities (Sassen, 2018).

In cities and regions that are less internationally connected and more characterised by industrial production than financial services, the labour market is also changing as businesses in traditional manufacturing industries in particular closing or downsizing. Here, too, the increasing automation of production and the growth in knowledge-intensive activities has been associated with a shift in the focus of employment from the secondary sector to the tertiary sector since the 1970s (Bosch & Wagner, 2002, p. 483). In the traditional industrial nations, the importance of quality products instead of mass-produced goods grew (Banik-Schweitzer & Blau, 2003). In order to survive in international competition, technologically advanced products and new organisational structures were needed, such as the just-in-time delivery system developed primarily in Japan. The German economy also succeeded in securing a leading role in the world market by specialising in technologically sophisticated products (Häußermann et al., 2008, p. 161).

The hallmark of the post-Fordist service society is an increasing individualisation and diversification of lifestyles (Schimank, 2012). Uniform employment relationships were replaced by atypical employment relationships. An increased share of leisure time also increased demand for cultural, gastronomic, and tourist services (Thuy, 1994, p. 64). Moreover, as women's roles changed, household and personal services, which had previously been performed as part of domestic work, were increasingly provided externally. In the labour

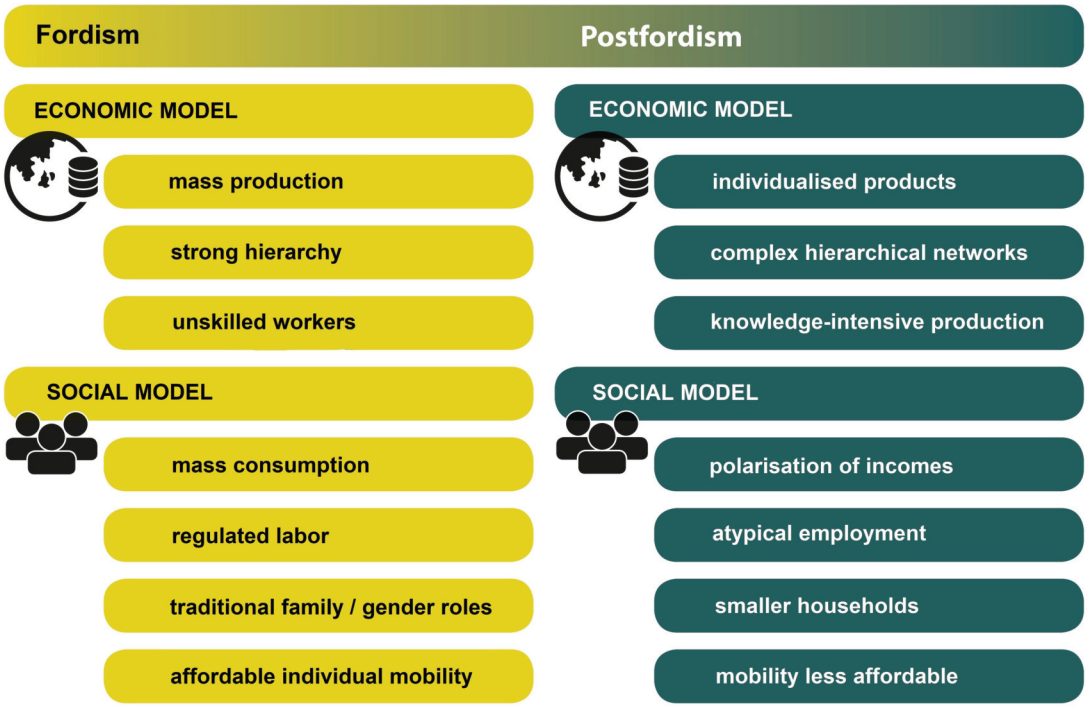

Figure 1. Comparison of the economic and social model of Fordism and post-Fordism.

market, women became particularly active in the social, health, and education sectors (Häußermann & Siebel, 1995, p. 186). Parallel to this, family and household forms also changed and the classic nuclear family lost importance—and with it, ultimately, the suburban way of life.

2.2. Urban Spatial Organisation and Industrial Area Layout

The production process of Fordism, which was subdivided into the smallest units, had an effect far beyond industry into the organisation of urban space. The principle of functional subdivision was also applied to urban structures and developed into the guiding principle of modernist urban planning in the 20th century. Urban life was divided in purely functional terms into areas for housing, areas for shopping and leisure centres and areas for work (Häußermann, 2012). The functional separation was intended to ensure healthy living conditions by separating residential areas in need of protection from factories that produced emissions. Industry was also characterised by enormous space requirements. A typical building form was the large industrial complex in low-rise construction. The land required for this was developed especially on the outskirts of the city. The more functional segregation prevailed, the more important mobility became. Together with the functionally structured city, large-scale traffic arteries emerged that linked the individual functional units of the city with each other. Added to this was the growing prosperity based on several decades of full employment. On this basis, mass automobilisation finally succeeded from the 1960s onwards, which promoted suburbanisation and led to the settlement area increasing disproportionately to the population growth.

In the context of post-Fordism, these paradigms changed and with them the planning strategies of cities. In the metropolises and global cities, the real estate industry is driving the creation of new office space and high-quality housing and shaping the transformation of city centres. In smaller cities and those traditionally more dominated by the manufacturing sector, this change is taking place less drastically, as the demand for office space is not quite as large here. However, structural change is also being systematically driven forward. With the abandonment of older industrial sites, freight stations, and harbour zones, larger areas are also becoming available, which are being developed as part of large-scale projects and as new service-oriented neighbourhoods. Particularly in cities and regions that have experienced a strong loss of jobs in the manufacturing sector, efforts are being made to provide new impetus for the economy and urban development in this way (Carter, 2016).

Particular importance is attached to projects areas alongside bodies of water like riverbanks, quay facilities, or the ocean coast, because not only is there often a lot of brownfield land available here, but the development of the waterfront also allows the creation of attractive urban spaces that give the new neighbourhoods a special atmosphere. Furthermore, the implementation of such projects is closely linked to a desire for a positive image for the city and region. With regard to a city's

image, spectacular cultural buildings are being erected as flagship-projects in order to increase tourist attention, cultural attraction, and, indirectly, attractiveness as an investment location. The best-known model for such a strategy is the city of Bilbao, Spain, which, since the opening of the Guggenheim Museum, has succeeded in transforming itself from a shipyard and port city into a tourist destination that attracts international visitors and is also gaining importance as a location for knowledge-intensive "productive services" (Camerin & Mora, 2019).

Projects like this indicate how the demands made on the design of urban space are changing. In the course of post-Fordism, reurbanisation tendencies are becoming visible, which indicate a trend reversal both with regard to the location choices of companies and with regard to the migration behaviour of the population. This trend reversal is due to several factors: The previously common spatial and temporal separation between work, home, and leisure is dissolving in the context of the knowledge society, whereby a mixed-use and urban environment is gaining in importance (Läpple, 2016, p. 24). In the private sphere, the dissolution of the family division of labour means that work and family can be organised more easily within mixed-use structures and short distances between home, workplace, childcare, and service facilities (Brandt et al., 2004, p. 141). In the business sector, the preference of employees for urban locations also leads companies to choose locations within urban structures, where they benefit from the availability of a well-trained workforce (Siedentop, 2008, p. 202).

A major driver of these developments is the process of change in industrial production itself (see Figure 2). A key aspect of post-Fordist restructuring is the disaggregation of the production process into multiple stages. As materials and components have to be moved between multiple manufacturing and assembly sites, this has increased the demand for transportation. From a global perspective, the ecological consequences of this growth in logistics must be assessed critically. However, the local effects are varying and depend on the kind of production. In Germany, many of the new high-tech production sites pollute the environment less than traditional industries were. Technical innovations reduce emissions and make industrial production increasingly compatible with uses requiring protection (Läpple, 2016, pp. 26–27). An increase in services in industry also contributes to a reduction in land requirements, as the service sector has a low land requirement per workplace compared to manufacturing (Rohr-Zänker & Müller, 2014, p. 5). However, it is not only new companies that are characterised by smaller structures: In Germany in particular, the secondary sector is strongly characterised by traditional craft and medium-sized production companies, whose flexibility and adaptability also open up good prospects for them in the context of structural change (Benke, 2021). Overall, this reinforces the trend towards smaller factory structures and thus smaller buildings in industrial areas.

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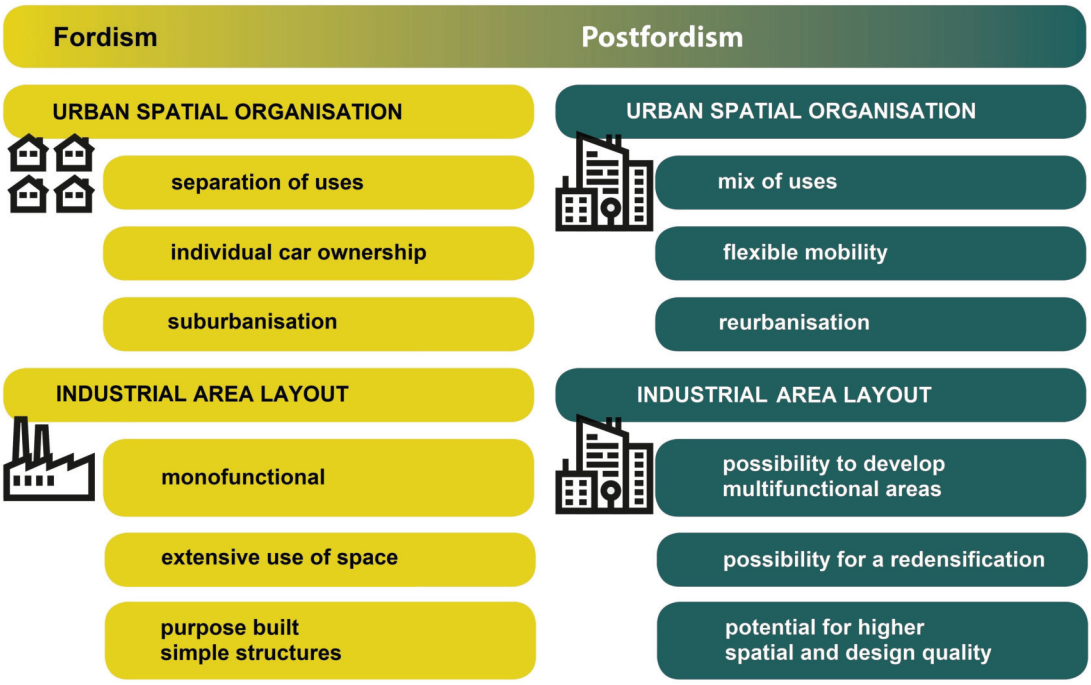

Figure 2. Comparison of the urban spatial organisation and industrial area layout in Fordism and post-Fordism.

logistics must be assessed critically. However, the local effects are varying and depend on the kind of production. In Germany, many of the new high-tech production sites pollute the environment less than traditional industries did. Technical innovations reduce emissions and make industrial production increasingly compatible with uses requiring protection (Läpple, 2016, pp. 26–27). An increase in services in industry also contributes to a reduction in land requirements, as the service sector has a low land requirement per workplace compared to manufacturing (Rohr-Zänker & Müller, 2014, p. 5). However, it is not only new companies that are characterised by smaller structures: in Germany in particular, the secondary sector is strongly characterised by traditional craft and medium-sized production companies, whose flexibility and adaptability also open up good prospects for them in the context of structural change (Benke, 2021). Overall, this reinforces the trend towards smaller factory structures and thus smaller buildings in industrial areas.

In addition to the quantity of space and the dimensioning of buildings, the demands on the quality of work locations are also changing in post-Fordism. Further to hard location factors such as land prices and transport connections, soft location factors are gaining in importance. From the perspective of the companies these are primarily the image and business climate of a region, proximity to universities and research institutions, qualification opportunities for skilled workers and the performance of public administration (Hüttenhain & Mayer-Dukart, 2010, pp. 185–186). And since highly qualified workers are sought after on the labour market, companies also attach importance to the design of the place of work as well as the working environment of their business. This includes landscape and urban qualities, leisure, and cultural facilities as well as childcare options (Hüttenhain & Mayer-Dukart, 2010, pp. 185–186).

The importance of such aspects for companies in the field of highly skilled professional services and their demand for inner-city office space has already been studied and discussed (Banik-Schweitzer & Blau, 2003). In addition to this, the following section will examine the extent to which companies in the manufacturing sector, which are located mostly in suburban industrial areas, are also having specific requirements regarding the urban design of their surroundings. For this purpose, we will focus on the situation in Germany, where a large part of the manufacturing industry specialises in technologically sophisticated products and needs highly skilled employees for this.

3. Adaptation Needs in Industrial Areas

One of the tasks of today's urban planning is to promote the sustainable development of cities and regions, which includes keeping greenfield development to a minimum, while at the same time possibilities for the transformation process of the economy and its spatial demands have to be created. An important approach is therefore the fact that, in the transition from Fordism to post-Fordism, location requirements have changed and the opportunity to create alternatives to the existing mono-functional industrial areas is increasing. But although post-Fordism largely replaced Fordism on the economic and social level, the functional separation of Fordism still persists in the built environment. As competition for qualified employees rises, the planning task is to adapt the industrially shaped spatial structures to a more knowledge-oriented economy and society. This also offers an opportunity to redesign the built environment of industrial areas.

If we take a closer look at industrial areas in Germany in the following pages, we do not distinguish the two use classes "heavy industrial" and "commercial and light industrial" as defined in German planning law, because large manufacturing facilities can be found in both: In Germany, only the locations of a few exceptionally large high-emission factories are designated as heavy industrial zones in the strictest sense. However, the vast majority of businesses and jobs in the manufacturing sector in Germany are located in commercial and light industrial areas (*gewerbegebiete*), which in German planning law allows nearly all functions of the secondary sector and the tertiary sector including most forms of industrial production as well as trade, crafts, logistics, wholesale, retail, offices, hotels, catering, and to a certain degree even housing for business owners and maintenance personnel. Looking at both types of industrial areas together, we are examining the changes within the secondary sector as well as the general shift from the secondary to the tertiary sector, including options for a redesign of the built environment of industrial areas in general. With the replacement of Fordist structures by post-Fordist structures, instead of functional separation and a simple utilitarian design, mixed-use structures and urban and architectural design qualities can gain in importance.

3.1. Functional Aspects

As a consequence of the functionalist planning idea, the small-scale linking of living and working was largely abandoned. In the course of the 20th century, the proportion of those neighbourhoods in Germany that exhibit functional diversity shrank from around 90% to around 10% (Feldtkeller, 2006, pp. 163–164). These overall planning goals have changed in recent years in favour of the model of the compact and mixed-use European city. However, despite the change in theory, commercial land development continues to take place predominantly under the guideline of avoiding conflict by separating functions (Hüttenhain, 2012, p. 17). For the future, tertiarisation and the transformation of industry will make it possible to bring back into the city the some of the manufacturing and service sectors that have been displaced to urban fringe areas. The options for functionally adapting commercial areas are manifold. Basically, a distinction

must be made between a coarse-grained mix of uses within a commercial area and a fine-grained mix of uses within buildings.

With regard to the coarse-grained mix of uses, the reduced emission load from industry and the reduction of factory sizes make it possible for manufacturing to come into spatial proximity to smaller-scale uses worthy of protection. Above all, the previously very extensive distance space between buildings become obsolete in the context of a coarse-grained mix of uses. Spatially segregated commercial areas can be better integrated into urban structures through the systematic appropriation of the existing underused distance spaces. One way to do this is to develop buffer zones. Many commercial areas have a diverse range of industries, each with different structural typologies and emission potentials, but which are diffusely distributed. Some of these industries, especially more modern production sites, have low emissions and small-scale building structures and therefore are able to create a buffer zone between large-scale working areas and residential uses. In this way, industrial areas can be subdivided into different sub-areas and thus more easily integrated into overall urban structures. The buffer zones serve as structural noise protection and ensure an urban transition from small-scale to large-scale development.

The fine-grained mix of uses within buildings is particularly relevant when it comes to replacing the dominant model of low-rise buildings with multi-storey buildings. As a consequence of limited space resources in agglomeration areas the re-organisation of business in the sense of vertical factories is on the rise. Here, special properties with increased ceiling load-bearing capacity, high rooms, wide corridors, and goods lifts guarantee production on several levels. The option of organising production floor by floor not only enables a mix of different sectors (e.g., shop on the ground floor and production on the floors above), but even a fine-grained mix of living and working (e.g., production on the ground floor and living on the floors above). Inner-city commercial areas in particular have the potential to realise more urbanity in these areas through the fine-grained mix of uses.

3.2. Urban Design and Architectural Aspects

In addition to their mono-functionality, traditional industrial estates are also characterised by land-intensive development. As a result, they not only contribute to increased landscape consumption, but also generate large amounts of commuter traffic due to their car-oriented structure. The recent expansion of the service sector, however, has reduced the land requirements per workplace. In addition, technical innovations in the manufacturing sector have also led to a reduction in land requirements per workplace (Rohr-Zänker & Müller, 2014, p. 5). Although this development is partly thwarted by the growing logistics sector with its large-scale storage and reloading facilities, the transformation processes in favour of the knowledge-intensive economy and new forms of production indicate that the quantitative requirements in industrial estates are changing significantly. This offers the opportunity to rethink commercial areas in terms of urban development and architecture.

Previously underused spaces can be activated by increasing density and adding storeys. The reduction of spatial requirements and new architectural solutions enable the development of compact structures in the sense of vertical factories. Through the conversion of oversized parking lots and underused open space, the hitherto unstructured street spaces can be developed as urban areas with an orientation-providing design. The differentiation of the buildings in terms of storeys makes it possible to create ground floor areas that enliven the street space and promote walking. Public spaces and open spaces can be qualified in terms of design and function in order to meet the growing needs of the knowledge society for its working environment. In place of a large quantity of lawns on hardly used distance areas, fewer but more valuable green spaces with a higher quality of stay can be created. And finally, in industrial areas, factors such as address formation and the need for presentation of individual companies gain in importance, so that architectural quality also becomes more important. Overall, this creates the opportunity to combine the adaptation of commercial locations to the changing needs of businesses with systematic redensification, which also increases the design and amenity quality of these areas.

4. Existing Industrial Areas and Their Transformation in the Kassel Region

The city of Kassel serves as an example of the post-Fordist transformation of a city. As part of our study, all commercial locations in the region were first recorded and their commercial and building structure surveyed. This was then analysed according to age, location, and building structure. Based on this survey, two different types of industrial areas can be formed: older areas near the city centre from the first half of the 20th century, which are characterised by a higher building density; and younger commercial areas located on the outskirts of the city or in suburban areas, which are characterised by a lower building density. In this section, examples for both types are presented, including an examination how production facilities have been transformed in the last 20 years, and to what extent this transformation is accompanied by a change in the building structure.

4.1. Extent and Form of Industrial Areas in the Kassel Region

The city of Kassel is located in the geographical centre of Germany, acts as the hub of the North Hesse region, and has an economically balanced development that lies

on average between the boom regions in the southwest of Germany and the structurally weak regions in the northeast. The city of Baunatal directly adjoins the city of Kassel in the south. Baunatal is a medium-sized town founded in 1964 as a result of the settlement of a Volkswagen (VW) AG factory. Both towns together form the region's densely populated area and are still strongly characterised by manufacturing industry.

In the course of the 19th and early 20th centuries, mechanical engineering and vehicle manufacturing emerged as Kassel's core economic fields. During National Socialism, Kassel also established itself as an important armaments' location with the production of tanks, military trucks, and aircraft engines. This led to Kassel becoming one of the main targets of Allied bombing raids during the Second World War, resulting in the destruction of around 80% of the city. The post-war decades in Kassel were characterised by extensive reconstruction. The reconstruction deliberately took place not in the sense of a restoration, but in the sense of modern urban planning models. For this reason, the idea of a city that is greened, car-friendly, and functionally segregated still determines Kassel's architectural image today.

As a result of the post-war building boom, a large number of industrial estates were created in Kassel and its surrounding municipalities, which at the time were laid out in suburban areas in a dispersed manner. As the manufacturing industry remains strongly anchored in and around Kassel to this day, many of the local industrial areas were developed specifically for production purposes. Due to the region's central location within Germany, logistics has also become another field of economic development in recent decades. Major national roads and railway lines converge in the region, so that destinations throughout Germany can be reached from here within a four-hour drive and transport cost advantages can be generated (Regionalmanagement NordHessen, 2016, p. 6). As a hotspot for logistics, specially designed commercial areas for logistics purposes have therefore been developed in the city region since the 1990s.

The stock of industrial areas therefore essentially consists of two groups. Firstly, there are the somewhat older sites from the early industrialisation phase up to the Second World War. Although they were built in peripheral locations at that time, the city has grown since then and numerous residential areas have sprung up in the surrounding area. These industrial estates are relatively small in size and are connected at their edges to the surrounding development. A concentration of these industrial estates can be found in the east of Kassel, the nucleus of the region's industrial development. In these commercial areas close to the city centre, transformation processes have been observed in recent years. The headquarters of SMA, one of Europe's leading manufacturers of photovoltaic systems and inverters, is located here.

On the other hand, there are the sites on the outskirts of Kassel or on the outskirts of neighbouring municipalities that were developed in the post-war period and were developed for production and logistics-oriented uses. These include the VW AG site in Baunatal, which consists of a production plant and a logistics centre. These areas are strongly characterised by large-scale structures and a separation from uses requiring protection, and these characteristics are even more pronounced at the newer, large-scale logistics sites (see Figure 3).

4.2. Comparison of the Region's Two Largest Employers: VW and SMA

The fact that the manufacturing industry is still strongly anchored in the region despite the structural changes in the economy is shown by the two largest employers, both of which belong to the secondary sector: VW AG, which operates one of the largest plants and its most important logistics centre in the region, followed by SMA Solar Technology AG (Wirtschaftsförderung Region Kassel, 2020).

With more than 10,000 employees at the Baunatal factory, VW is the largest employer in the Kassel economic region. In 1957, VW AG set up a production plant on the site of an aircraft engine factory a few kilometres south of the city of Kassel, which was built during the Second World War and had since been little used. In the course of suburbanisation, new residential areas sprang up, particularly in this part of the region, especially around the VW factory. The newly founded town of Baunatal was formed in 1964 from a merger of three former villages. The newly planned centre of this community lies at some distance from the monolithic VW complex with its 1,400 metres length and 570 metres width. In between are large green corridors and traffic facilities as separating elements. Close by, but functionally independent of this production plant, a second facility was built in 1994 on a site a little further to the southeast, the Original Parts Centre's logistics base, which bundles VW AG's European spare parts supply. This facility is almost as large as the production plant and is also a monolith isolated from the city. Both complexes are very purpose-built. The industrial estate is located at the intersection of the A49 and A44 motorways and is thus extremely conveniently situated in terms of transport. Although a tram line running between Kassel and Baunatal also leads to the area, overall, it is very car-oriented in design. The area is mainly used by VW. Next to the gigantic buildings there are almost equally large parking areas for VW AG employees. Only on the edges of the industrial estate have a few other businesses set up shop, either in logistics or in a car-oriented sector, including haulage companies and petrol stations. The edges of the industrial estate are separated from the rest of Baunatal's residential areas by mostly agricultural land.

SMA is one of the second largest employers in the Kassel economic region (Wirtschaftsförderung Region Kassel, 2020). Unlike VW AG, SMA Solar Technology AG

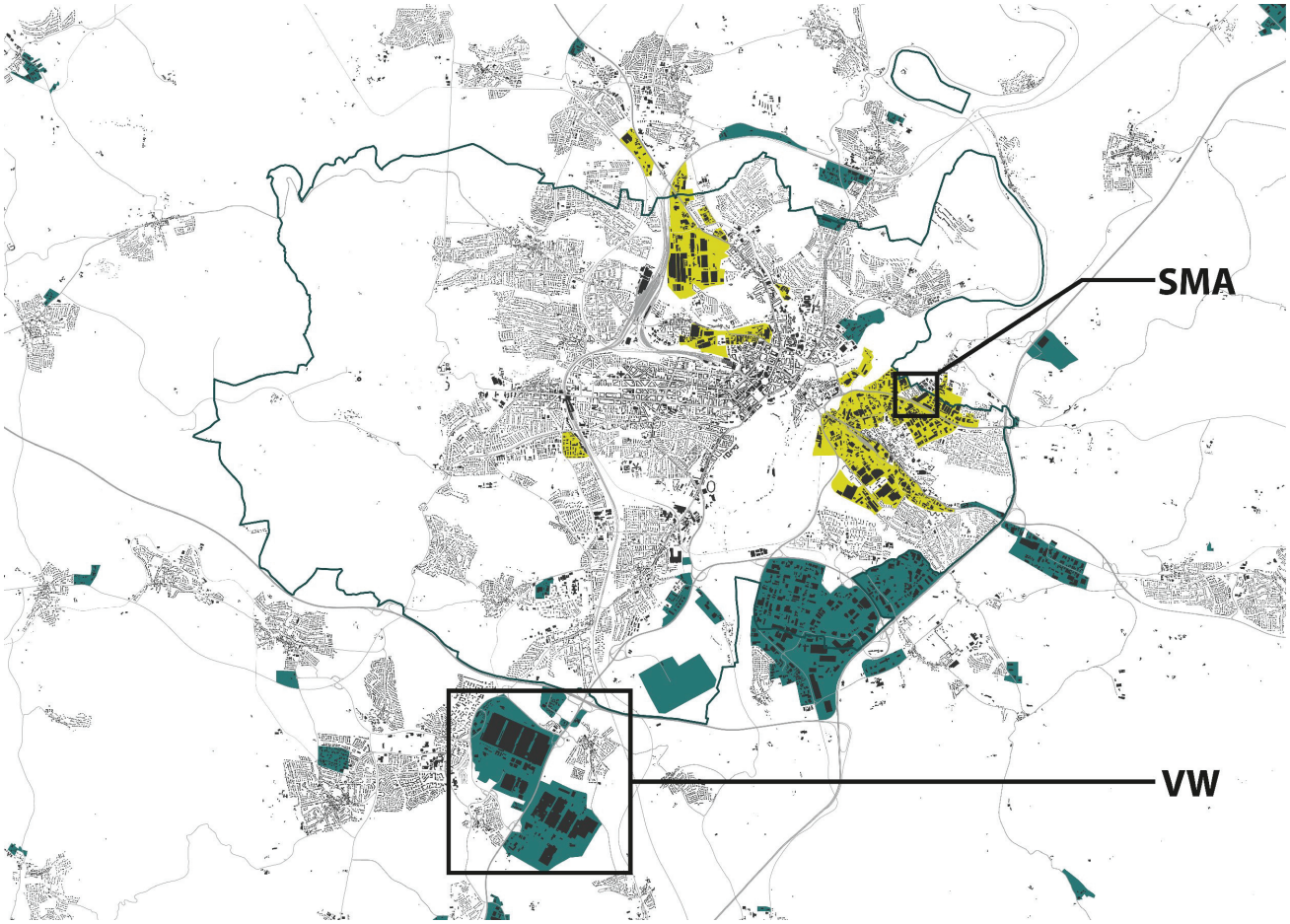

Figure 3. Existing older integrated (yellow) und suburban (green) industrial areas in the Kassel region, including the location of VW and SMA factories. Source: Authors' own depiction based on a map by OpenStreetMap Contributors (2020).

does not have such a long tradition in the region. The company was founded in 1981 out of the University of Kassel. Since the turn of the millennium, it has built new facilities in Kassel and the neighbouring municipality of Niestetal. A comparison of the SMA production site with the VW plant in Baunatal clearly shows the upheaval that has taken place in terms of the location requirements of production companies. In this sense, SMA's choice of location as well as the urban and architectural design refers to post-Fordist production conditions and differs considerably from VW's Fordist approach. SMA has settled in an integrated location, on the edge of one of Kassel's oldest industrial areas. Unlike VW, the company does not have a monolithic building structure for all its purposes. Instead, the individual building units are distributed throughout the industrial areas, optimising the use of the scarce land resources in inner-city locations. This has resulted in campus-like areas characterised by comparatively small building layouts, multi-storey buildings, and a high building density. SMA's office and production spaces were designed in a compact architecture to ensure that they blend in with the small-scale residential and commercial buildings in the immediate vicinity. SMA's architectural design also differs from classic production facilities: Instead of a purely functional design, the SMA complex is designed as a representative part of an urban district. With this in mind, SMA has built the Solar Factory 1, which stands out architecturally from the surrounding buildings, on Kassel's busy entrance and exit road, Dresdener Straße. The factory building has two to five storeys and provides views into the building and the production process through extensive glass facades. SMA thus marks a transformation process in Kassel—from separated and space-intensive to integrated and structurally compact production plants. This way, it shows how urban production can have a positive effect on the physical layout and design quality of an industrial area.

5. Beginning Transformation, Currently Planned Measures, and Possible Systematic Redevelopment

In the Kassel city region, which is strongly characterised by manufacturing industry, socio-economic structural change is not only expressed in terms of business activity and occupational structures, but also in the built environment. With regard to the function and structural design of industrial areas, the first transformation processes are becoming apparent that open up potential for functional mixing and space savings. The commercial areas are developing away from being a separate place of work

to becoming an integral part of urban structures. Due to their location, these transformation processes are more pronounced in inner-city commercial areas than in suburban commercial areas. In the following, two of these transformation processes are examined in more detail using the example of the Waldau-West industrial estate, in a suburban location, and the Bettenhausen industrial area, in an integrated location.

5.1. Waldau-West Industrial Estate

The Waldau-West industrial estate was developed in the 1970s on the site of a former airfield. The area is located on the outskirts of the city in the south of Kassel. Since the 1990s, the area was enlarged and the older western and the newer eastern parts are today marketed together under the common name "Industriepark Kassel-Waldau" (Stadt Kassel, 2021). The area has very good transport links due to its proximity to the A7, A44, and A49 motorways and a connection to the rail freight network. Currently, more than 200 companies with more than 4,000 employees are located in the area. The companies are mainly from the manufacturing sector. In addition, it is used by wholesale, logistics, and service industry businesses (Stadt Kassel, 2021).

Due to the time of the area's development and the strong influence of manufacturing industry, Fordist urban structures are still evident in the area today, which no longer meet the requirements of modern commercial enterprises. Waldau-West is characterised by large-scale production and storage halls and a simple design of flat buildings. In some parts, the area has two to three-storey office buildings. The building stock has both structural and energy deficits. Accessibility of the area by public transport is limited, so that private automobile transport dominates. On most lots, the flat buildings are surrounded by large open space that is either landscaped as a lawn, used as a car park, or sealed as an open storage area. These underused areas are a large reserve that has not yet been properly used. In addition, the abandonment and relocation of some businesses in recent years has led to properties in the area being vacant or areas falling into disuse (Bundesinstitut für Bau-, Stadt- und Raumforschung, 2016, p. 18).

As a result of these deficits, the city of Kassel took part in a nationwide research programme (ExWoSt) to counteract further negative developments and to develop strategies for the qualification of the area together with the local businesses and the Kassel Region Economic Development Agency. Within the framework of this programme, it was possible to define practical fields of action that are to be worked on in the future in network-like cooperation and with the help of an area management as a central contact point in the area.

5.1.1. Beginning Functional Transformation

The partial vacating of older buildings and spaces has given rise to a number of uses that are untypical of the area (including a bowling alley, go-cart track, tax consultants), which could initiate a structural change in the area (Bundesinstitut für Bau-, Stadt- und Raumforschung, 2016, p. 18). The city of Kassel would like to prevent an unplanned conversion of the area into an office area or mixed area in order to secure this area for commercial and industrial businesses. By drawing up a development plan, the existing industrial area is thus to be secured under planning law and changes of use prevented. For

Figure 4. Kassel-Waldau industrial area. Source: Charlotte Reiher.

this purpose, the educational institutions already located in the area—several vocational training schools—are very important. These educational institutions are closely linked to the industrial uses of the area, which results in advantages for businesses in the area. In this context, the educational institutions are also to be preserved and supported by defining their location in the development plan as a "special education area" (Zweckverband Raum Kassel, 2020, pp. 3–4). Through this measure, the city of Kassel secures a sector mix that is limited in scope, but which benefits the resident companies and thus the attractiveness of the location for the manufacturing industry, so that a further relocation of companies, for example to greenfield sites, can be prevented.

5.1.2. Planned Further Transformation

As part of the planning process for the sustainable development of the Waldau-West area, the participation of local businesses also played an important role. During a participation event, a transformation of the area into a green production location was identified as the central vision for the future of the area. With this in mind, green design objectives are to be incorporated into the preparation of the development plan in order to profile it as a green industrial park, also in terms of improved amenity qualities (Stadt Kassel, 2021). Another overarching goal is to improve the attractiveness of the location and thereby retain skilled workers. To this end, the image of the business park is to be upgraded, which also implies measures at the construction level. Brownfield sites are to be brought back into use and operational reserve areas are to be activated. This can lead to a densification of the area (Bundesinstitut für Bau-, Stadt- und Raumforschung, 2016, p. 19). In addition, greater importance is now attached to the protection of resources in the form of energy efficiency, environmental and climate protection, and subsequent uses (Bundesinstitut für Bau-, Stadt- und Raumforschung, 2016, p. 19). Furthermore, the aim is to improve the accessibility of the area through intermodal mobility. In order to counteract the heavy sealing in the area, it is also planned to bundle the parking spaces of various businesses more strongly (Bundesinstitut für Bau-, Stadt- und Raumforschung, 2016, p. 19).

5.2. Bettenhausen Industrial Area: Dresdener Straße

The Bettenhausen district of Kassel represents a nucleus of the industrial development of the city region. Monuments to industrial history have been preserved in the industrial area to this day, including the Messinghof, a former brass works, and the Salzmann & Comp. industrial building, which used to be a textile factory. The importance of the Bettenhausen industrial area as a location for classical production is still evident beyond the industrial monuments. In the 20th century, the industrial area continued to develop in the sense of Fordist production and the associated effects on the urban space. Land-intensive development structures and large-scale building blocks were created, surrounded by extensive transport infrastructure facilities for the benefit of the car-oriented city. Mobility within the area is accordingly characterised by a strong car orientation, although it is in an urban integrated location. The physical appearance of the area is predominantly determined by simple, single-storey hall architecture with adjoining office buildings, so that the area has only a low structural density. The buildings are arbitrarily placed on the plots without orientation towards the street, so that in combination with large-scale traffic areas, hardly any street spaces are formed. The parts that are not built over are mainly used as parking spaces and storage and manoeuvring areas.

Since the 2000s, a functional transformation process can be observed in the Bettenhausen industrial area. On the one hand, this transformation process affects the manufacturing industry itself, and, on the other hand, it affects the functional orientation of the industrial area, in which an increasing number of non-manufacturing businesses have settled. Retailers, restaurants, and a few cultural institutions, including a nightclub, amusement arcades, and a mosque have been added, so that a wide range of uses predominates in the area today. These uses benefit from the proximity to Kassel's sales market on the one hand and the regional accessibility through the proximity to the A7 motorway junction on the other.

Furthermore, the transformation of industrial production itself is evident in the area. Mainly, SMA's combination of headquarters and production facilities in the area shows that modern production can be organised in a way that is compatible with the city and in a small space. Finally, a conversion of an industrial monument no longer needed for commercial purposes, the Salzmann factory, is currently taking place. Together with the city of Kassel, an investor is planning a complete renovation of the building stock in order to eventually convert it in favour of flats, a nursing home, and a hotel.

The functional transformation of the area opens up potential from which both the quality of the commercial area itself and the surrounding urban neighbourhoods can benefit. They offer the possibility of transforming the Fordistic cityscape of the industrial area in favour of small-scale and urban structures. In view of the area's location, its current status as a foreign body between residential areas can also be transformed by integrating it more into the urban fabric. The extensive spectrum of uses that has emerged in the area not only points to a mixture of uses in the sense of a broader mix of industries, but also offers the opportunity of a stronger mixing of commercial and residential uses. The combination of residential and commercial uses is already being practised in individual parts of the area: At the edges of the Bettenhausen area some smaller businesses have been founded on lots that combine a residential building with an adjoining small building for commercial activities, i.e., car repair shops. This creates a good transition,

Figure 5. Kassel-Bettenhausen old residential area and new industrial area. Source: Charlotte Reiher.

both functionally and structurally, between residential and small-scale building structures on the one hand and commercial and large-scale development on the other. This development, which is rather accidental and not initiated by planning, could be used more systematically in the course of a further functional transformation to create buffer zones between residential and industrial functions. In this sense, the uses should be staggered in such a way that large-scale and emission-intensive activities take place in the interior of the area, while uses become more small-scale and more compatible with residential areas on the outside.

6. Conclusion

As can be seen in the transformation process of the Kassel region, post-Fordist change of production methods and location needs requires a new planning approach to industrial areas and opens up possibilities for a reintegration of manufacturing into the city. This structural change in the economy has not only brought about positive developments with regard to employment structures, because many jobs disappear and even more could disappear in the future, resulting in income and employment polarisation. This makes it all the more important to adapt industrial areas not only to a changed economy, but also to a changed society. The industrial area stock of the post-war decades was built in the wake of a prosperous suburbanising middle class with long-term employment and affordable car mobility. In the meantime, employment relationships and incomes, household types as well as forms of mobility have become highly differentiated, and these differentiations can be seen in the current reurbanisation trends. Since people as well as businesses are more eager to move back into the city, industrial areas do not have to be fully separated anymore but can be transformed into integrated mixed-use urban spaces.

This combination of different functions is possible in two different forms: a coarse-grained mix of uses within an industrial area or a fine-grained mix of uses within buildings. The options depend on the location and characteristics of the respective industrial area. However, as the examples from the Kassel region show, such a transformation seems to be easier to realise in inner-city areas than in areas on the outskirts. In areas near the centre the limited land resources and the historically dense coexistence of residential and commercial areas make it possible to locate production facilities that are open to new solutions in terms of integrated location and building design. In this way, they can generate an impulse with regard to urban planning and architectural quality as well as the quality of stay in public spaces, as was the case in Kassel-Bettenhausen. In contrast, the pressure for densification in areas that are spatially separated from the city is not as high as in integrated locations. In addition, these industrial areas are still home to businesses that depend on spatial separation from emission-sensitive uses. As the example of the Waldau-West industrial estate has shown, deficits in terms of building stock, appearance, and accessibility by public transport have a negative impact on the attractiveness of these industrial estates, leading to derelict sites and vacancies. In cases like this it is important to preserve and protect areas for classic production and at the same time meet the requirements of workers and employees as well as the requirements of new more knowledge-based businesses.

All in all, it becomes clear that a change in the planning approach to industrial areas opens up potential in two respects. Firstly, economic restructuring will keep changing the demand for commercial and industrial buildings, but redensification of existing industrial areas can prevent the use of too many greenfield sites for this purpose. Secondly, overcoming the functional separation of residential and commercial areas enables better networking with the city, improves accessibility for pedestrians and other non-car users, and opens up potentials for higher spatial and design quality. Both elements are important factors of a meaningful integration of industrial areas into the urban fabric and in the long term can contribute to the sustainable development of urban regions.

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Conflict of Interests

The authors declare no conflict of interests.

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